

U.S. DEPARTMENT OF COMMERCE  
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BUREAU OF AIR COMMERCE  
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AIRWORTHINESS REQUIREMENTS  
FOR ENGINES AND PROPELLERS

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CONTENTS

AIRWORTHINESS REQUIREMENT FOR ENGINES AND PROPELLERS

**Chapter I.--AIRCRAFT ENGINE REQUIREMENTS**

**Section 1. General**

(A) The requirements contained in this chapter are those regulations dealing with the design, construction, and testing of engines for use in licensed aircraft. The requirements pertaining to the installation of engines in licensed aircraft are contained in sections 65 to 71, inclusive, of Aeronautics Bulletin No. 7-A. These regulations are supplemental to, and a part of, the Air Commerce Regulations specified in Aeronautics Bulletin No. 7. They are also supplemental to Aeronautics Bulletin No. 7-A, which outlines the airworthiness requirements for aircraft, and Aeronautics Bulletin No. 7-F, covering the airworthiness requirements for aircraft accessories.

(B) Aircraft except light aircraft as defined in section 2(B) of Aeronautics Bulletin No. 7-A, and except free balloons and gliders, in order to be rated as airworthy shall be equipped with engines which are approved by the Secretary of Commerce. Light aircraft may be equipped with unapproved engines which have been assigned a rating by the Secretary as to maximum power and speed.

(C) The manufacturer shall prove the airworthiness of his engine to the satisfaction of the Secretary by technical data and suitable tests. The requirements herein outlined furnish a guide as to the minimum technical data, test equipment, and testing required for the approval of the conventional internal combustion engine in which the fuel is gasoline or a blend of gasoline with some volatile liquid. Special rulings for other types of engines will be made as the occasion develops.

**Sec. 2. Procedure Relative to Approval**

(A) Manufacturers submitting commercial engines for approval or rating shall conduct or arrange for all of the tests necessary to comply with the requirements contained herein. Military engines which have passed the regular endurance tests of and are approved by the United States Army Air Corps or the Bureau of Aeronautics, Navy Department, may be approved in accordance with section 9.

(B) Engines which comply with sections 4, 5, 6, 7, 9, and 10 to the satisfaction of the Secretary of Commerce may be approved for use in licensed aircraft. Engines which comply with sections 4 and 8 to the satisfaction of the Secretary are assigned a rating for use in licensed light aircraft. Approved engines may be granted an approved type certificate at the option of the manufacturer, provided the manufacturing facilities for producing engines of exact similarity in quantities are satisfactory to the Secretary.

(C) When an approved type certificate is granted, one set of drawings is impressed with the seal of the Department of Commerce and is returned to the manufacturer to be used in the construction of his engines. The other set is placed in the Department's files. The Department's inspectors may call for, and must have access to, these approved drawings when making an inspection at the manufacturer's plant to determine whether the engines as built conform to the approved data.

(D) Any major deviations from the approved drawings must be approved in advance by the Secretary. A change shall be considered major within the meaning of these regulations if it affects the reliability or power output of the engine in any way. In all doubtful cases the decision of the Department shall definitely establish the category within which a specific change shall be included.

(E) Information accompanying a request for approval of a major change to an approved engine shall include sufficient technical data, including reports of tests where necessary, certified by the responsible representative of the manufacturer, to demonstrate to the satisfaction of the Secretary that the changed engine is airworthy. In cases where it is deemed necessary by the Secretary an endurance test witnessed by an authorized inspector for the Department of Commerce will be required to substantiate the airworthiness of specific changes. Tests of this kind are particularly applicable when a change is such as to affect materially the power output of the engine.

(F) On January 1 and July 1 of each year a manufacturer of an approved engine shall submit for approval and file drawings pertaining to all the minor changes made to that engine during the preceding 6-month period. Engines are approved for use in licensed aircraft only so long as their component parts are of approved design and manufacture.

(G) An approved type certificate is valid for as long a period of time as the manufacturer desires it to continue in force provided that suitable manufacturing facilities are continuously maintained, and further provided that engines which conform with the airworthiness requirements to the satisfaction of the Secretary are being manufactured in accordance with the terms of the certificate. Manufacturing facilities are understood to include qualified personnel. The Secretary reserves the right to survey the outstanding approved-type certificates periodically and to withdraw those for which such action is deemed advisable because of any of the reasons enumerated herein or in section 3 of these regulations.

(H) Approved-type certificates are nontransferable but may be reissued to a manufacturer other than the original holder, with the original holder's consent, provided the former meets all the requirements pertaining thereto.

(I) A manufacturer to whom an approved-type certificate has been issued shall file his affidavit with the Secretary on January 1 and July 1 of each year showing the number of engines constructed in exact accordance with the terms of such certificate during the preceding 6 months. This report shall include the serial numbers or other identification marks for all the engines involved, together with the dates of manufacture and any other pertinent information.

(J) Technical data furnished by a manufacturer for XXX.

### **Sec. 3. Revocation or Suspension of Approval**

Aircraft engine approvals and or approved-type certificates may be suspended or revoked for any of the following reasons:

(A) Violation of the Air Commerce Act or any regulations promulgated thereunder, on the part of the manufacturer.

(B) Failure of the manufacturer to make proper and seasonable reports.

- (C) Any false statement on the part of the manufacturer in application for approval or information accompanying the application or in any report required under these regulations.
- (D) Use or display of an approved-type certificate or other official notification from the Department of Commerce for fraudulent purpose or misrepresentation of any approved product.
- (E) Use or display of an approved-type certificate or other official notification from the Department of Commerce in any manner contrary to the public safety or interest.
- (F) Any demonstration of incompetency, carelessness, or negligence, or the use of inferior or improper material, on the part of the manufacturer.
- (G) Failure of the manufacturer to maintain sufficient and suitable equipment and personnel to insure the airworthiness and exact adherence to approved specifications of the engines manufactured.
- (H) Refusal of the manufacturer to submit to inspection under proper demand by a representative of the Secretary, or to render any reasonable assistance in connection therewith.
- (I) Moral irresponsibility of the manufacturer.
- (J) Unsatisfactory operation of approved engines in service, provided that the cause of the unsatisfactory condition is within the control of the engine manufacturer.

#### **Sec. 4. Design requirements**

- (A) Engines of more than 100 horsepower shall be equipped with dual ignition systems having at least two spark plugs per cylinder.
- (B) All engines and engine accessories shall be so designed and constructed as to reduce to a minimum the chances of failure to function in the air and, so far as is possible, to prevent fires during flight or in the event of a crash.
- (C) Provision shall be made for the installation of a means for preventing ice forming in the carburetor.
- (D) Engines shall operate smoothly with no undue vibration at speeds which are to be used for continuous operation.
- (E) The fuel system of an engine shall be of such design that it will continue to supply a satisfactory mixture when tilted to the various angles encountered in normal flight.

#### **Sec. 5. Commercial Sea Level Engines**

**(A) Data required.**--In the case of engines which have not been previously approved by the Army or Navy, and for which the manufacturer desires the approval of the Secretary, the following information shall be submitted:

- (1) Application for approved type certificate, in duplicate, submitted on forms which will be furnished for the purpose by the Secretary.
- (2) XXX type for which approval is desired. The test shall be of at least 100 hours duration with 50 hours at full throttle with an average speed within plus or minus 3 percent of the proposed rated speed and 50 hours at 75 percent proposed rated power at propeller load speed. The submission of this test report will be waived by the Secretary for modified engines of a type previously tested which do not incorporate changes in the general arrangement, number of cylinders, displacement, or an appreciable increase in power or speed.

(3) Suitable data describing the status of the engine to be submitted for official tests. The manufacturer may submit any engine, regardless of its previous history, provided all defects which became apparent in the 100-hour manufacturer's test have been explained and/or corrected to the satisfaction of the Secretary. The data shall also include the permissible maximum and normal cylinder head temperatures determined by the manufacturer for the engine.

(4) A complete set of drawings descriptive of the engine, in duplicate. Drawings of small standard commercial parts need not be submitted, but all other drawings applying to the engine, including those of the assembly and installation shall be included. The material shall be specified on the drawings by reference to a specification number of the Army, Navy, S.A.E., or other such recognized standard wherever possible. If the manufacturer refers to his own specification numbers, details of those specifications shall be furnished the Secretary. All drawings should be folded to a size approximately 9 by 12 inches, with the title showing. All drawings received from a specific manufacturer will be filed together, arranged numerically, so that, if certain of the drawings required for a particular engine are identical with drawings previously submitted and approved in connection with a prior type of engine, made by the same manufacturer, such identical drawings need not be again submitted. In order to eliminate a possible source of controversy, the Secretary cannot accept drawings which may be altered after approval. Blueprints, photostats, or the equivalent are satisfactory.

(5) A complete parts list, in duplicate, showing the drawing number and name of each of the component parts of the engine and arranged numerically,

(6) A detailed report, supported by affidavit, of a 10-hour flight test of the engine. This test shall include a climb at full throttle to 15,000 feet or to the service ceiling of the airplane which should be loaded to a reasonable gross weight. The report shall completely describe the test and the results thereof and shall include names of persons involved, dates, and particulars of the airplane. The engine used for this test may be the same engine as that submitted for test or another engine of the same type.

**(B) Procedure for submitting data and conducting tests.**--Upon receipt of satisfactory data in accordance with paragraphs (A)(1), (2), and (3), the Secretary will authorize an inspector to examine the manufacturer's testing facilities. If the facilities conform to paragraph (C) of this section, the inspector will witness the official tests and tear down inspections outlined in paragraphs (D) and (E) of this section. Approval of the engine is then contingent upon the submission of a satisfactory report by the manufacturer in accordance with section 7, signed by the inspector, and the data described XXX.

**(C) Testing equipment.**--Equipment satisfactory to the Secretary shall be provided by the manufacturer with the necessary personnel to conduct the tests outlined in paragraphs (D) and (E) of this section. The following equipment represents a minimum for this purpose:

(1) Electric cradle dynamometer (may be used in conjunction with a water brake absorbing up to XXX percent of the total horse-power) or torque stand (requires air straightening grid when used for calibration runs). A fixed stand may be used for the endurance test outlined in paragraph (D) of this section.

(2) Propellers suitable for maintaining the speeds and power outputs required.

(3) Tachometer or other accurate means of indicating r.p.m. (Counter and stop watch required for frequent checks.)

(4) Manometer for measuring manifold pressure.

(5) Means for measuring engine air intake pressure and temperature.

(6) Oil pressure gage.

(7) Suitable thermometers to measure oil inlet and outlet temperatures.

- (8) Manometer or air-speed indicator to measure air velocity over the cylinder head of air-cooled engines. (To be measured at approximately half way between the cylinders in line with valve heads where practical.)
- (9) Thermocouples for all cylinder heads and barrels of air-cooled engines. (To be located at rear spark plug gasket and near rear cylinder hold-down nut on thrust side.)
- (10) Suitable thermometers to measure liquid inlet and outlet temperatures with liquid cooled engines.
- (11) Apparatus for measuring fuel consumption by weight or volume.
- (12) Apparatus for measuring oil consumption by weight.
- (13) Barometer, dry and wet bulb thermometers.

**(D) Endurance test.**--A XXX full throttle endurance test shall be run in periods of at least XXX hours each on consecutive working days and witnessed by an authorized inspector for the Department of Commerce.

- (1) The engine shall be run with the speed approximately equal to the proposed rated speed and with the manufacturer's recommended setting of the ignition timing, mixture control, and intake heat control. The fuel used during the test will be the lowest grade approved for use in the engine. Excessive adjustments to the engine during the course of the test will be considered by the Secretary as a cause for rejection. Dependence upon excessive fuel and/or oil consumption for proper cooling during the test will also be considered cause for rejection.
- (2) During the endurance test not more than three forced stops caused by the engine shall be allowed. Failure of accessories shall not necessarily be considered as forced stops. A run of 5 hours shall be added to the test for each forced stop made. If the power in a dynamometer run drops as much as 10 percent, due allowance being made for atmospheric conditions, this shall constitute a forced stop. If the endurance test is run with a propeller, variations in speed of plus or minus 3 percent are permissible. Variations in speed in excess of this amount due to atmospheric conditions will not be considered a forced stop but the propeller shall be changed to correct for the conditions. Excessive water, fuel, or oil leaks developing at the engine shall constitute forced stops. In all cases the Secretary shall be the judge as to what constitutes a forced stop. An engine failure of a type which would cause an immediate forced landing in flight or require the replacement of a major part of the engine shall terminate the test.
- (3) Complete readings of the performance of the engine shall be recorded at least every half hour throughout the endurance test. The following readings are essential:
  - (a) R.p.m.
  - (b) Manifold pressure.
  - (c) Temperatures of the two hottest cylinder heads and barrels if air cooled, or inlet and outlet liquid temperatures if liquid cooled.
  - (d) Fuel consumption.
  - (e) Oil consumption.
  - (f) Oil inlet and outlet temperatures.
  - (g) Oil pressure.
  - (h) Air velocity or pressure XXX over the cylinder heads if air cooled.
  - (i) Barometer.

(j) Temperature (dry and wet XXX).

(k) Engine air inlet temperature and pressure.

**(E) Calibration test.**--A full throttle power calibration of the engine shall be made after the endurance test outlined in paragraph (D) and witnessed by an authorized inspector for the Department of Commerce.

(1) Full throttle runs shall be made at approximately 100 r.p.m. intervals from 75 to 110 percent of the proposed rated speed by varying the load to determine a curve of power versus speed. Each speed shall be maintained for at least 2 minutes, or until operating conditions have stabilized, before a reading is taken.

(2) The engine shall be operated during the calibration test at the manufacturer's recommended setting of the ignition timing, mixture control, and intake heat control. The power rating assigned to the engine by the Secretary will correspond to the corrected horsepower obtained during the calibration test at a speed within 25 r.p.m. of the average speed maintained during the endurance test. This corrected horsepower is the observed horsepower corrected to standard conditions for the pressure, temperature, and humidity existing in the air intake of the carburetor just before the venturi. Standard conditions are a barometric pressure of 29.92 inches of mercury, an air temperature of 60 degrees F., and a water vapor pressure of 0.39 inch of mercury. It is recommended that a suitable correction satisfactory to the Secretary be further applied to the horsepower when the calibration test is conducted with cooling air of a temperature and velocity which differs materially from 60 degrees F. and the velocity normally to be encountered in flight.

(3) Essential readings for each run during the calibration test XXX observed horsepower, and corrected horsepower shall be recorded and the oil consumption need not be recorded.

(F) At the conclusion of the endurance or calibration tests the engine shall be operated at various speeds throughout its operating range in the presence of the inspector for the Department of Commerce to demonstrate the idling, acceleration, and running characteristics.

**(G) Tear-down inspection.**--After completion of the endurance and calibration tests a complete tear-down and detailed inspection of engine parts shall be made, particular attention being paid to excessive wear or signs of failure. The inspector for the Department of Commerce will check the conformity of the engine parts with the set of drawings to be submitted by the manufacturer. As a result of the inspection, the Secretary may require such revisions and/or additional tests as appear necessary to establish the airworthiness of the engine, or may reject the engine and require its resubmission, notwithstanding the completion of the tests described in paragraphs (D) and (E).

**(H) Geared engines.**--The tests required for geared engines are the same as those for direct-drive engines. Unless the horsepower loss due to reduction gears is appreciable, geared engines may, at the option of the engine manufacturer, retain the same rating as a previously approved identical engine with direct drive.

## **Sec. 6. Commercial Altitude Engines**

**(A) Tests.**--Engines which are not designed for full throttle continuous operation at sea level shall be tested and rated as altitude engines. The requirements for approval of these engines are identical to those outlined in section 5 with the following exceptions:

(1) The manufacturer's test outlined in section 5(A)(2) may be conducted at proposed rated power instead of at full throttle.

(2) The flight test shall be in accordance with section 5(A)(6) except that the engine need not be operated at full throttle below the rated altitude.

(3) The endurance test shall be conducted at a power and speed of at least that at which the manufacturer desires the engine to be rated. In lieu thereof, when the engine is highly supercharged, the test may be conducted at at least the manifold pressure which the engine will develop at rated speed at the proposed rated altitude. In such a case, an identical engine except for the supercharger drive shall be tested at the power and speed at which the manufacturer desires the engine to be rated. Where the engine is highly supercharged and is endurance tested at less than rated power, it will be limited for take-off operation to the power developed during this endurance test unless an additional test, suitable to the Secretary, is made to establish the airworthiness of the engine for short periods of operation at higher outputs.

(4) The calibration test shall consist of the following:

(a) A full throttle calibration at sea level in accordance with section 5(E) except that outputs above the proposed rated power need not be maintained 2 minutes before a reading is taken. This calibration may be omitted if the engine is highly supercharged.

(b) Constant speed runs shall be made by varying the load and the throttle to determine curves of horsepower versus manifold pressure. Curves shall be obtained for each 100 r.p.m. from 100 r.p.m. in excess of the proposed rated speed down to the manufacturer's recommended cruising speed of the engine. Such curves shall extend from approximately 75 percent of the average manifold pressure of the engine during the endurance test to 110 percent of the manifold pressure for the particular speed.

**(B) Rating of altitude engines.**--The rated altitude shall be that altitude at which the engine develops the manufacturer's rated power and speed at full throttle under standard altitude conditions with the grade of fuel used during the endurance test. When equipment is available, tests simulating altitude conditions shall be made to determine the rated altitude and the characteristics of the engine between the rated altitude and sea level. In lieu of such testing the Secretary will accept such empirical methods of determining the altitude performance of the engine as are substantiated by simulated altitude tests of similar engines or by extensive flight tests. The manufacturer shall in each case submit for the consideration of the Secretary all references, test data, and curves upon which the manufacturer's estimate of the altitude performance is based.

**(C) Limitations applied to altitude engines.**--The manufacturer shall submit to the Secretary suitable curves descriptive of the performance of the engine for take-off, climb, cruising, and high speed at all altitudes between sea level and the rated altitude. It is recommended that these curves be plotted on a single sheet with horsepower versus r.p.m. for sea level and horsepower versus altitude above sea level. Full throttle, part throttle, constant manifold pressure, and constant speed lines shall be indicated. The manufacturer shall also indicate on these curves the limitations desired. The Secretary will issue limiting instructions for the operation of the engine, a copy of which the manufacturer shall supply with each engine delivered for service use. Section 65(B) of Aeronautics Bulletin No. 7-A outlines the operating limitations applied to altitude engines.

## **Sec. 7. Test Report**

(A) The manufacturer of an engine which is tested in accordance with section 5 or 6 shall prepare a suitable report describing the test equipment, testing and tear-down inspection. The report shall be completely descriptive of the test, including all essential details. The report shall be certified to and signed by the responsible representative of the engine manufacturer and shall include the following information:

(1) A description with photographs of the testing equipment. (This description need not be included if a previously approved report adequately describes the equipment used.)

(2) A chronological history of the endurance testing covering the events of each period of running. All irregularities, failures, and forced stops shall be fully discussed. A table or chart showing all readings recorded during the test shall be included.

(3) A description of the calibration testing with a table of all readings and the corrections used. The results shall be plotted as curves of B.M.E.P., corrected horsepower, manifold pressure, cylinder head or cooling liquid temperatures, and fuel consumption.

(4) Description of the condition of the engine parts as found from the complete tear-down and detailed inspection of the engine after testing. Photographs of all failures or excessively worn parts shall be included.

(5) Photographs of the engine, front, side, and two three-quarter views from the rear.

## **Sec. 8. Special Light Aircraft Engines**

**(A) Data required.**--In the case of engines which are to be installed in light aircraft as defined in section 2(B) of Aeronautics Bulletin No. 7-A, and for which the manufacturer desires the Secretary to assign a maximum power and speed rating only, the data submitted shall include the following:

(1) An application for rating, submitted on the same form as is furnished by the Secretary to applicants for approved type certificate. When used for this purpose the form shall be altered by the applicant by crossing out the words "Approved Type Certificate" in the heading and substituting the word "Rating."

(2) One set of general assembly drawings, sufficiently well dimensioned to show the general specifications of the engine.

**(B) Tests required.**--The power rating may be obtained from tests by the engine manufacturer, the Army, or the Navy. A rating test shall consist of a 5-hour run on a test stand with the throttle wide open, and the speed equal to the speed at which a rating is desired. If the corrected horsepower cannot be determined satisfactorily from this test, a calibration test may be made after the 5-hour run. A complete report of the rating test shall be submitted to the Secretary. It shall include a detailed log of the 5-hour test and a description of the test stand and instruments used. Details of the equipment and calculations used to determine the corrected horsepower also shall be included.

## **Sec. 9. Military Engines**

(A) In the case of engines which have previously been approved by the Army or Navy and for which the manufacturer desires Department of Commerce approval, the following data shall be submitted to the Secretary:

(1) Applications as described in section 5(A)(1).

(2) A copy of the official Army or Navy endurance test report which was the basis of the military approval, signed by the Army or Navy representative who witnessed the test. It is not necessary for the manufacturer to submit this report where such report has previously been forwarded to the Secretary through official channels. In cases where the report is being prepared by the military agency, the Secretary, to expedite approval, will accept a copy of the official approval of the engine, which shall include the military rating and calibration curves.

(3) Drawings as described in section 5(A)(4).

(4) A parts list as described in section 5(A)(5).

(3) A report of a flight test as described in section 5(A)(6), or a statement from the Army or Navy to the effect that such flight tests have been satisfactorily conducted in the Army or Navy service.

## **Sec. 10. Modified Engines with Change in Power or Speed**

(A) In a case where a manufacturer desires the approval of the Secretary for an engine which is a modification with a change in power output and/or speed from a previously approved engine of the same manufacturer, data shall be submitted and tests conducted as follows:



(1) If the manufacturer desires to increase the rated power and/or rated speed, or if the modification is of a sufficient extent to require endurance testing, the modified engine shall be considered a new design which will be eligible for approval upon compliance with sections 5, 6, or 9, whichever may apply.

(2) If no increase in rated power and/or rated speed is involved and if the modified engine is a minor modification of the approved engine, and technical data are submitted to the Secretary which demonstrate conclusively that the airworthiness of the modified engine is equal to that of the approved engine, data shall be submitted in accordance with paragraphs (A)(1), (A)(4) and (A)(5) of section 5, and a report of calibration testing shall be submitted in accordance with sections 5(B), 6(A)(4), 6(B), 6(C), and 7(A)(3) whichever may apply.

#### **Sec. 11. Engine Parts**

(A) Only structural engine parts which are approved by the Secretary may be used to modify, maintain, or repair approved engines.

#### **Sec. 12. Engine Accessories**

(A) Engines will be tested and approved as a complete power plant, including all engine accessories that are attached to the engine and are essential for the proper operation of the engine in the air. Cowling, exhaust manifolding, and mufflers need not be included as these items are subject to inspection and approval in each type installation on licensed aircraft. Propellers, propeller hubs, and propeller blades are also subject to separate approval under the requirements outlined in chapter II of those regulations.

(B) At the time of the endurance tests the Secretary will require such tests as are necessary to determine the airworthiness of the engine with the attached accessories. It is recommended that the manufacturer submit, at the time of the test, optional accessories with which he may desire the engine to be approved. Engines may be approved with other optional accessories or changes in accessories provided the airworthiness of the engine with the new accessories is demonstrated by sufficient technical data, including certified reports of tests where necessary. Additional endurance tests of the engine as described in section 5 or 6 may be necessary if the accessory change constitutes a major modification to the engine.

(C) Engine accessories as described in the above paragraphs of this section are not eligible for separate approval.

#### **Sec. 13. Engine Speed**

An approved engine or a special light aircraft engine as described in Section 8 is not eligible for operation in excess of the rated speed except for the purpose of setting fixed or adjustable pitch propellers. Engines installed on licensed aircraft shall be equipped with approved propellers which limit the engine speed in accordance with section 66 of Aeronautics Bulletin No. 7-A.

#### **Sec. 14. Identification Data**

All engines used in licensed aircraft shall be provided with an identification plate which is permanently attached to the engine. It shall be readily accessible when the engine is installed in the aircraft and shall contain the following information: Name and model designation of the engine, manufacturer's name, serial number, approved maximum power, approved rated speed, impeller or supercharger gear ratio, carburetor venturi size, and octane number of the lowest grade of fuel permissible. For altitude engines the rated altitude shall also be given on the identification plate.

### **Chapter II.--AIRCRAFT PROPELLER REQUIREMENTS**

#### **Sec. 15. General**

(A) The requirements contained in this chapter are those regulations dealing with the design, construction, and testing of propellers for use in licensed aircraft. The requirements pertaining to the installation of propellers in such aircraft are contained in section 66 of Aeronautics Bulletin No. 7-A. These regulations are supplemental to, and a part of the Air Commerce Regulations specified in Aeronautics Bulletin No. 7. They are also supplemental to Aeronautics Bulletin No. 7-A which outlines the airworthiness requirements for aircraft and Aeronautics Bulletin No. 7-H containing the air commerce regulations governing alterations and repairs to licensed aircraft.

(B) Aircraft, except light aircraft as defined in section 2(B) of Aeronautics Bulletin No. 7-A, and except free balloons and gliders in order to be rated as airworthy shall be equipped with propellers which are approved by the Secretary of Commerce.

(C) The manufacturer is required to prove the airworthiness of his propeller to the satisfaction of the Secretary by technical data and suitable tests. The requirements herein outlined furnish a guide as to the minimum technical data, test equipment, and testing required for the approval of the conventional screw propeller which is in general use at the present time. In the event that new types are developed, such that these regulations may not logically be applied in their entirety, special rulings to cover these cases will be made by the Secretary.

(D) When, in the judgment of the Secretary, adequate and satisfactory methods of testing other than those outlined herein are available, propellers tested by those methods may be eligible for approval.

#### **Sec. 16. Procedure Relative to Approval**

(A) Manufacturers submitting propellers for approval shall arrange for or conduct all tests necessary to comply with the requirements herein outlined. Military propellers which have passed the regular endurance tests of and are approved by the United States Army Air Corps, or the Bureau of Aeronautics, Navy Department, may be approved in accordance with section 20.

(B) Propellers which comply with the requirements herein outlined to the satisfaction of the Secretary may be approved with a maximum horsepower rating and a maximum speed rating for use in licensed aircraft. Detachable propeller hubs and propeller blades are approved, as separate units and the word "propeller", as herein used, applies where applicable, to propeller hubs and to blades as well as to complete propellers. Approved propellers may be granted an approved type certificate at the option of the manufacturer, provided that the manufacturing facilities for producing propellers of exact similarity in quantities are satisfactory to the Secretary.

(C) When an approved type certificate is granted, one set of drawings is impressed with the seal of the Department of Commerce and is returned to the manufacturer to be used in the construction of his propellers. The other set is placed in the Department's files. The Department's inspectors may call for, and must have access to, these approved drawings when making an inspection at the manufacturer's plant to determine whether the propellers built conform to the approved data.

(D) Any major deviation from the approved drawings must be approved in advance by the Secretary. A change shall be considered major within the meaning of these regulations if it affects the reliability or airworthiness of the propeller in a manner not obviously beneficial. In general, a change may be considered major when it involves a material alteration to a part, the failure of which would prevent the aircraft from continuing flight to an emergency landing field. In all doubtful cases the decision of the Department shall definitely establish the category within which a specific change shall be included.

(E) Information accompanying a request for approval of a change to an approved propeller shall include sufficient technical data, including stress analysis and certified reports of tests where necessary, to demonstrate to the satisfaction of the Secretary that the changed propeller is airworthy. If the change is to a different blade shank size, engine shaft size, blade airfoil or propeller material, application should be made for a new approved type certificate. A change to a new maximum power rating or maximum speed rating, if it constitutes a structural modification to the propeller, will also precipitate a new approved type certificate.

(F) On January 1 and July 1 of each year a manufacturer of an approved propeller shall submit for approval and file drawings pertaining to all the minor changes made to that propeller during the preceding 6-month period. Propellers are approved for use in licensed aircraft only so long as all of their parts are of approved design and manufacture.

(G) An approved type certificate may cover reduction in diameter from that of the propeller tested, provided that there are no variations in the cross-sectional dimensions of the blades or any increase in rating. The diameter of a propeller blade may be reduced by cutting off the tip of the blade and fairing the immediate vicinity or by telescoping the center sections of the blade. The drawings submitted shall show the details of the smaller blades for each 6-inch reduction in radius over the range for which approval is requested.

(H) An approved type certificate is valid for as long a period of time as the manufacturer desires it to continue in force, provided that suitable manufacturing facilities are continuously maintained, and further provided that propellers which conform with the airworthiness requirements to the satisfaction of the Secretary are being manufactured in accordance with the terms of the certificate. Manufacturing facilities are understood to include qualified personnel. The Secretary reserves the right to survey the outstanding XXX type certificates periodically and to withdraw those for which such action is deemed advisable because of any of the reasons enumerated herein or in section 17 of these regulations.

(I) Approved type certificates are nontransferable but may be reissued to a manufacturer other than the original holder, with the original holder's consent, provided the former meets all the requirements pertaining thereto.

(J) A manufacturer to whom an approved type certificate has been issued shall file his affidavit with the Secretary on January 1 and July 1 of each year, showing the number of propellers constructed in exact accordance with the terms of such certificate during the preceding 6 months. This report shall include the serial numbers or other identification marks for all the propellers involved, together with the dates of manufacture and any other pertinent information.

(K) Technical data furnished by a manufacturer for approval will be treated as confidential.

#### **Sec. 17. Revocation or Suspension of Approval**

Aircraft propeller approvals and or approved type certificates may be suspended or revoked for any of the following reasons:

(A) Violation of the Air Commerce Act or any regulation promulgated thereunder on the part of the manufacturer.

(B) Failure of the manufacturer to make proper and seasonable reports.

(C) Any false statement on the part of the manufacturer in applications for approval or information accompanying the application or in any report required under these regulations.

(D) Use or display of an approved type certificate or other official notification from the Department of Commerce for fraudulent purpose or misrepresentation of any approved product.

(E) Use or display of an approved type certificate or other official notification from the Department of Commerce in any manner, contrary to the public safety or interest.

(F) Any demonstration of incompetency, carelessness, or negligence, or the use of inferior or improper material, on the part of the manufacturer.

(G) Failure of the manufacturer to maintain sufficient and suitable equipment and personnel to insure the airworthiness and exact adherence to approved specifications of the propellers manufactured.

(H) Refusal of the manufacturer to submit to inspection upon proper demand by a representative of the Secretary, or to render any reasonable assistance in connection therewith.

(I) Moral irresponsibility of the manufacturer.

(J) Unsatisfactory characteristics which may appear in approved propellers in service.

#### **Sec. 18. Design Requirements**

(A) Propellers shall be designed to operate without excessive vibration or flutter and shall be constructed of materials which are suitable for service conditions.

(B) The surface of propeller blades shall be smooth and faired with respect to the thickness and the moments of inertia about the major and minor axis with no abrupt curvatures or irregularities along the blades. Critical surfaces of metal propeller hubs shall be machined smooth without tool marks and all changes in cross section shall be faired with as large a fillet as possible.

(C) It is recommended that propeller designs be so arranged that the weakest portion of the propeller blade or hub may be inspected without disassembly and that excessive wear or a partial failure will precede a serious type of failure.

(D) To facilitate inspection wood propellers shall be finished so that the grain of the wood is visible.

#### **Sec. 19. Commercial Propellers**

**(A) Data required.**--In the case of propellers which have not been previously approved by the Army or Navy, and for which the manufacturer desires the approval of the Secretary, the following information shall be submitted:

(1) Application for approved type certificate, in duplicate, submitted on forms which will be furnished for the purpose by the Secretary.

(2) A complete set of drawings descriptive of the propeller, in duplicate. All details of the propeller shall be shown, including the profile and plan form of the blade, the size of blade cross sections at frequent stations, the hub design, and the materials of construction. The material shall be specified on the drawings by reference to a specification number of the Army, Navy, S.A.E., or other recognized standard wherever possible. If the manufacturer refers to his own specification numbers, details of those specifications shall be furnished the Secretary. All drawings should be folded to a size of approximately 9 by 12 inches, with the title showing. In order to eliminate a possible source of controversy, the Secretary cannot accept drawings which may be altered after approval. Blueprints, photostats, or the equivalent are satisfactory. In the case of complex mechanisms such as controllable hubs, the drawings submitted will be filed numerically, so that if certain of the drawings required for a particular propeller are identical with drawings previously submitted and approved in connection with a prior type propeller made by the same manufacturer, such identical drawings need not be again submitted. In such cases there shall also be submitted a complete parts list in duplicate, showing the drawing number and name of each of the component parts of the propeller mechanism and arranged numerically.

(3) A complete log, covering the tests outlined in paragraphs (B) or (C) of this section accompanied by an affidavit. This shall include a detailed record of the test with dates, names of persons involved, name and model number of engine or name, model number and Department of Commerce number of airplane, and hours of testing with corresponding engine speeds. The report shall also include the results of a detailed inspection of the propeller after the test in accordance with paragraph (D) of this section.

(4) A stress analysis as required in conjunction with flight testing in paragraph (B) of this section or where, in the judgment of the Secretary, the design is sufficiently unconventional to require it.

**(B) Tests required for propellers other than fixed pitch wood propeller.--**

(1) Propellers of this type shall be subjected to a 50-hour endurance block test on an internal-combustion engine, rigidly mounted of the same general characteristics as the engines upon which the propellers are to be used in service or on an engine acceptable to the Secretary. The test may be run without a stop or may be broken into runs of 5 hours or more each. The cylinder bore of the engine used for the test will determine the maximum bore of the engine with which propellers of this type shall be eligible for use. This test shall be run at the proposed rated speed of the propeller with the propeller so adjusted as to absorb its proposed rated power. If the engine is not run at full throttle and horsepower measurements are not possible during the test, manifold pressure readings shall be taken at frequent intervals. A suitable calibration curve shall be used to determine the power absorbed by the propeller during the test. The power rating assigned to the propeller by the Secretary may correspond to the corrected horsepower absorbed by the propeller if the engine used for the test is of the type on which the propeller is to be used in service. In the case of controllable or automatic pitch propellers, the pitch changing mechanism shall be operated throughout the usable power range at least once each hour of the test. The engine may be throttled to prevent overspeed when changing pitch. After the 50 hours of testing, controllable or automatic pitch propellers shall be operated at as close to rated power and speed as possible for periods of 5 minutes each at various pitch settings, such as 1 degree steps throughout the operating range. All variations in running characteristics of the propellers shall be recorded. In the case of propellers having a restricted number of pitch settings they shall be run at these settings.

(2) Propellers of this type which are sufficiently similar to previously approved propellers of the same manufacturer so that their airworthiness may be demonstrated to the satisfaction of the Secretary by a comparative stress analysis, to be submitted by the manufacturer, may be subjected to a 50-hour flight test in lieu of the test outlined in paragraph (1). The flight test shall be conducted on an engine of equal or greater power and speed than that for which the approved rating is requested. At least 5 hours of the test shall be run at the proposed rated speed of the propeller. The stress analysis shall compare the pertinent aerodynamic, centrifugal, vibration, and torque impulse load differences between the respective propellers by a mathematical comparison, where possible, and by suitable curves plotted with the radius of the propeller as abscission. Curves descriptive of the fairing of the propellers shall also be included where applicable.

(3) It is recommended that metal propellers of this type be tested also by suitable methods to determine their natural frequencies within all ranges of major vibrations which are produced by the operation of the engines on which such propellers are to be used. These frequencies should be determined at all blade angles within the operating range of the propellers. Data covering these tests should be submitted to the Secretary in the form of curves and tables. The type of frequency should be described and the XXX located for each frequency.

**(C) Tests required for fixed pitch wood propellers.--**

(1) Propellers of this type shall be subjected to a 10-hour endurance block test on an internal-combustion engine, or a 50-hour flight test. In the case of a block test the entire test shall be run at the proposed rated speed of the propeller. In the case of a flight test 5 hours shall be run at the proposed rated speed of the propeller. This test shall be conducted with an engine of equal or greater power and speed than that for which the approved rating is requested.

**(D) Inspection of a tested propeller.--**

(1) As stated in paragraph (A)(3) the log of the flight or engine test shall include the results of a detailed inspection of the propeller after the test. This shall include photographs of any failures or suspected failures. A propeller which fails during the testing is not eligible for approval unless the failure is of such a nature that the strength of the propeller is not impaired and a minor modification to the propeller will prevent future failures of this type.

(2) A failure of a metal propeller is defined as actual breakage, cracking, or permanent set of any part of the blades, hub, bolts, lock nuts, splines, keyways, slipping of the blade in its clamping socket, seizing or pitting of bearings, or jamming of the automatic or controllable pitch mechanism. Aluminum-alloy propellers shall be etched at all critical

portions and examined for minute cracks with a magnifying glass. Steel propellers shall be subjected to both a magnetic and visual inspection for signs of failure. Wood propellers will be considered to have failed if the tipping pulls or cracks, glue joints open, or if there is any local failure or crushing around the hub or bolts. Similar considerations will apply to propellers of any patented composition or variation of the conventional wood or metal construction.

#### **Sec. 20. Military Propellers**

(A) In the case of propellers which have previously been approved by the Army or Navy and for which the manufacturer desires Department of Commerce approval, the following data shall be submitted to the Secretary:

(1) Applications as described in section 19(A)(1).

(2) A copy of the official Army or Navy endurance test report which was the basis of the military approval, signed by the Army or Navy representative who witnessed the test. It is not necessary for the manufacturer to submit this report where such report has been previously forwarded to the Secretary through official channels. In cases where the report is being prepared by the military agency, the Secretary, to expedite approval, will accept a copy of the official approval of the propeller which shall include the military rating, length of test, and the output and model designation of the test engine.

(3) Drawings as described in section 19(A)(2).

#### **Sec. 21. Propellers with Minor Modifications from Approved Propellers**

(A) In the case of propellers which embody only minor modifications from propellers constructed by the same manufacturer which have previously been approved by the Department of Commerce and which require a new approved type certificate, the following data shall be submitted to the Secretary:

(1) Applications as described in section 19(A)(1).

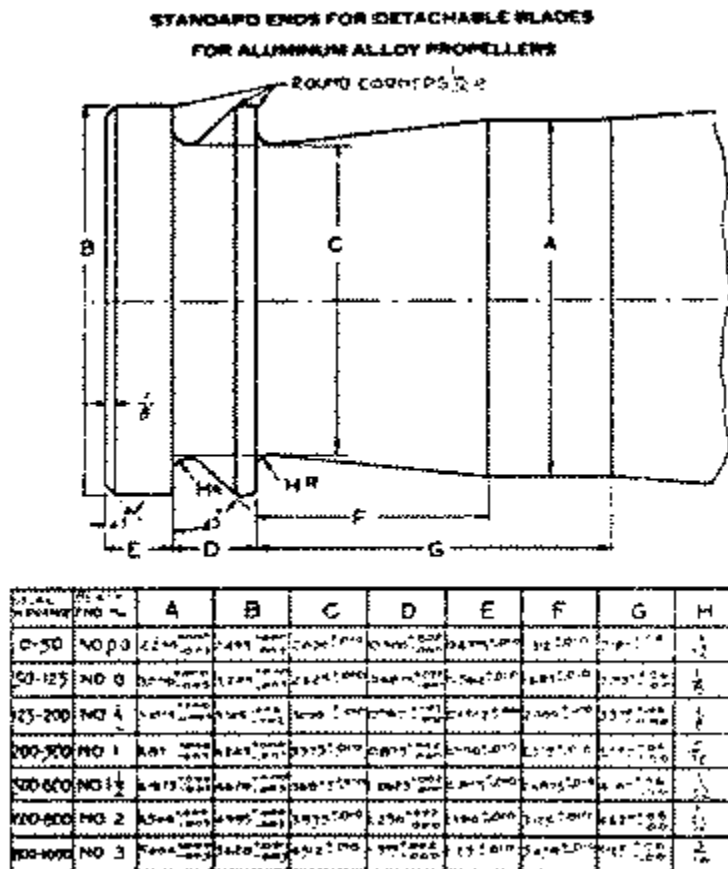
(2) Drawings as described in section 19(A)(2).

(3) Technical data which demonstrate conclusively that the airworthiness of the modified propeller is equal to that of the approved XXX.

#### **Sec. 22. Recommended Standards**

It is recommended that manufacturers conform as far as practicable to Army and Navy or S.A.E. standards in hubs blade shanks, etc. Blade shank standards are shown in figure 1. The fillet radii indicated should not be decreased in any case.

STANDARD ENDS FOR DETACHABLE BLADES FOR ALUMINUM ALLOY PROPELLERS



**Figure 1.** The horsepower range in this table represents the normal range of the particular size blade end in a two blade propeller, but should not be used for design purposes, or as a basis for obtaining approval.

### Sec. 23. Damaged Propellers

The approval of propellers which have been bent or injured is canceled until repairs have been made by a competent concern. This does not apply to minor injuries which do not affect the strength or smoothness of a propeller. The Secretary should be promptly informed by the operator of any propeller accidents and the kind and extent of any major XXX

### Sec. 24. Limiting Speed

An approved propeller is not eligible for operation in excess of the maximum rated speed except for the purpose of setting fixed or adjustable pitch propellers. Propellers shall be installed and operated on engines in licensed aircraft in accordance with section 66 of Aeronautics Bulletin No. 7-A.

### Sec. 25. Identification Data

(A) All approved propellers, propeller blades, and propeller hubs shall have conspicuously displayed upon them the following information: Name and model designation of the propeller, manufacturer's name, serial number, maximum power, and maximum speed for which approval has been granted.

(B) The identification data shall be permanently attached by means of a plate, stamping, engraving, etching, or other such method upon a noncritical surface of the propeller blade or hub. Where such data are not visible when the propeller is assembled or installed on an airplane they shall also be painted or printed on the propeller blade or hub.